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APPLICATION FOR PATENT

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TITLE: DISPOSAL OF WASTE MATERIAL THROUGH PELLETIZING AND AGRICULTURAL/HORTICULTURAL USE

SPECIFICATION

BACKGROUND OF THE INVENTION

This application is a continuation-in-part of co-pending application serial number 08/228,443, filed April 15, 1994, now pending.

This invention relates to the use of paper products and to the disposal of waste products through such application for soil enhancement and/or replacement, and for weed and wind erosion control.

Waste cellulosic material constitutes a large portion of the solid waste currently being disposed of in landfills. Some cellulosic material is managed by composting, but some, such as newsprint, is resistant to decomposition by composting. A technique to dispose of cellulosic material in large quantities would be very desirable.

Many cellulosic materials, such as recycled paper, create a rather sterile growth medium for plants. Also, cellulosic material such as waste paper mats when wetted, resulting in a poor medium for plant growth. A technique for providing waste cellulosic material in a form well suited for use as a plant growth medium would be very desirable.

It has been suggested to dispose of certain cellulosic material by application to agricultural soils. However, incorporating certain cellulosic materials such as ground newsprint into the soil of agricultural land stunts crop growth, at least during the first few weeks. It appears that the waste paper may be competing with the plants for moisture and

nitrogen. Further, cellulosic materials with high aluminum contents, such as ground newsprint, release aluminum into the soil, which has a long lasting effect of stunting root growth. A technique for applying newsprint or other waste cellulosic material to agricultural soils in a manner that does not harm crop yields would be desirable.

Certain cellulosic material, such as ground newsprint, other paper and gin trash, is also difficult to handle and apply in large quantities. It has a low bulk density and paper products are subject to caking when exposed to moisture. A technique for making cellulosic material easier to handle and apply to agricultural lands would also be desirable.

When applied to the surface of the soil, many cellulosic materials, such as ground paper, are easily blown by the wind. A technique to improve reliable placement of the cellulosic material for surface applications would be very desirable. Also, the 1985 Farm Bill requires all farmland that is classified as highly erodible by the Soil Conservation Service to reduce erosion to a manageable level by 1995. However, in many agricultural areas in the U.S. not enough plant residue is produced during the growing season to meet these Federal requirements. To achieve this goal, most farmers will have to plant cover crops during fallow periods and leave crop residue on the soil surface. An alternative method of providing surface cover would be desirable.

When buried in agricultural lands, ground newsprint is very resistant to degradation. A technique to improve the speed of degradation of buried ground newsprint would be desirable.

A major challenge facing producers of poultry, cattle, swine, horses and sheep is the disposal of the large amounts of animal waste generated. Poultry litter, especially, has a high nitrogen content. However, as a nutrient source for corn, poultry litter has proven to be a less effective source of nitrogen than commercial ammonium nitrate. This has sometime lead to excessive applications of poultry litter to farmland, resulting in contaminated runoffs. A technique for an environmentally sound soil treatment that utilizes animal waste has the potential for broad based benefits.

Waste products such as waste paper, lawn clippings, wood chips, gin trash, banana peels, shrubbery, sugar cane, sorghum, other vegetation and plastics are filling landfills. Alternatives to current disposal of these products would be very desirable.

OBJECTS OF THE INVENTION

It is an object of this invention to provide paper, especially waste paper such as newsprint, in a form so that it is highly suitable for horticultural and agricultural uses.

It is another object of this invention to provide a plant growth medium comprised of a paper product.

It is yet another object of this invention to provide a technique for using animal waste for horticultural and agricultural purposes.

It is another object of this invention to provide a technique for reducing soil erosion with paper products, especially waste paper products.

It is yet another object of this invention to dispose of waste material, including sludge and other industrial wastes, using a pelletization technique that reduces soil erosion.

It is another object of this invention to provide a method for weed control using paper products, especially waste paper products.

It is a further object of this invention to provide a soil amendment technique using cellulosic material products, especially waste products such as waste paper, lawn clippings, wood chips, gin trash, banana peels, shrubbery, sugar cane, sorghum and other vegetation.

It is another object of this invention to meet the above objects while simultaneously disposing of non-paper waste materials.

The potential benefits from application of waste paper such as newsprint to farmland as a soil amendment is dependent on geographical location. In the Southeast, incorporation of newsprint can improve the physical and chemical properties of soil, thus increasing soil aggregation and infiltration while reducing sediment loss by surface runoff. In drier regions, newsprint applications may have the added benefits of conserving soil water resources while reducing sediment loss by wind erosion.

SUMMARY OF THE INVENTION

In one embodiment of the invention there is provided a method for applying aggregates containing ground, non-paper material to soil. The non-paper material, usually waste material, may be from organic or nonorganic sources.

In another embodiment of the invention, there is provided a method for applying aggregates containing ground, non-paper waste material selected from the group consisting of wood, wood chips, lumber, sawdust, brush, branches, grass clippings, leaves, yard wastes, straw, stalks, gin trash, bagasse, grain hulls, peels, sorghum, sugar cane, animal byproducts, clothing, organic sludge and a mixture of any two or more to soil.

In yet another embodiment of the invention, there is provided an aggregate containing ground up waste material. The waste material can be organic or inorganic. Organic materials include wood, wood chips, lumber, sawdust, brush, branches, grass clippings, leaves, yard wastes, straw, stalks, gin trash, bagasse, grain hulls, peels, animal byproducts and organic sludge. Inorganic materials can be sheetrock, gypsum, roofing materials, fiberglass, foam board, plastic, polystyrene, rubber, and inorganic sludge.

In another embodiment of the invention, there is provided a growth medium for plants comprising a bed of aggregates containing ground up organic matter. The organic material can be wood, wood chips, lumber, sawdust, brush, branches, grass clippings, leaves, yard wastes, straw, stalks, gin trash, bagasse, grain hulls, peels, sorghum, sugar cane and animal byproducts. The aggregates contain a source of assimilable nitrogen sufficient to provide a C:N atomic ratio between biodegradable carbon and nitrogen from the nitrogen source of between about 10:1 to about 60:1.

BRIEF DESCRIPTION OF THE DRAWINGS

The Figure is a pictorial representation of an aggregate containing ground paper according to one embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In one embodiment of the invention, there is provided an aggregate containing ground paper. Generally, the paper is ground to a screen size of 10 cm or less, usually, to a screen size of 3 cm or less, and preferably to a screen size of between about 0.2 and about 2 cm. Hammer mills can be used. Any paper can be used, but the invention will probably have its greatest benefit when applied to recycled paper, including newspapers, telephone books, magazines, computer paper, corrugated paper, etc. Waste or excess paper or pulp recovered from manufacturing processes can also be used. The selection of the desired paper is an economic one, rather than a technical one.

By aggregate is meant a cluster of ground paper particles. Preferably, the aggregate is consolidated by compacting ground paper particles under conditions of added moisture, for example by pelletizing or briquetting, to form pellets or briquettes of ground paper.

The formation of pellets of ground paper is known, but not commonly used in the paper recycling industry. A pelletizing machine which extrudes pellets in the form of an extrudate has been used with good results. It is also believed that a briquetting machine, such as is used for the manufacture of charcoal briquettes, would also be useful, as well as equipment for pelletizing animal feeds. For certain applications, however, the aggregate may be in the form of crumb or broken cake. For these applications, broken up pellets or briquettes form a highly suitable material.

The particle size and shape of the aggregates depends on the desired application. For application on the surface of the soil for weed control, and as a soil substitute, a relatively small particle size is believed best suited. For deep burial, larger aggregates may be used. For application to mitigate wind erosion and/or form a ground cover to retain soil moisture, an intermediate size is probably best suited. Where the pellets are to be tilled into the soil, a wide range of sizes are suitable, although small particles will be assimilated more quickly than larger ones.

Generally speaking, the particle size, as expressed in terms of average volume of a major portion of the aggregates, can range from about 0.01 cc to about 1200 cc. Usually, the

aggregates will have a volume in the range of from about 0.1 cc to about 800 cc. Preferably, the aggregates will have a volume in the range of from about 0.5 cc to about 150 cc, because it is believed that aggregates having a volume in this range will be useful for most applications. However, for some applications, such as soil replacement or weed control, it may be desirable to form mixtures of aggregates with a volume in the range of 0.5 cc to 150 cc with smaller aggregates which may be in crushed or crumbled form such as those having a size in the range of from about 0.02 cc to about 0.5 cc., although even smaller aggregates such as those having a volume as small as 0.005 cc may also be used. For use as a growth medium, the aggregates will generally have a volume of less than about 1 cc.

The aggregates can also be described as having a major dimension and a minor dimension. The minor dimension is preferably less than 5 cm to aid in breakdown and assimilation by the soil. The major dimension is preferably less than about 30 cm to aid in mixing in the soil with standard agricultural implements. The minor dimension is preferably greater than about 0.15 cm and the major dimension is preferably greater than about 0.3 cm for reasons of economy in production and handling.

Generally speaking, the aggregates are produced in pellet or briquette form, and can have any desired configuration, such as circular, square, or flattened cross section. The currently preferred aggregate is presently an elongated extrudate with a circular cross-section, because it has been tested with good results. The presently preferred aggregate is generally arcuately shaped and has a length in the range of about 0.1 to about 30 cm and a diameter in the range of from about 0.1 to about 5 cm. Even more preferably, the extrudate has a length in the range of from about 1 to about 15 cm and a diameter in the range of from about 0.2 to about 1.0 cm. An extrudate having a length closely encompassed by the range of from about 2 to about 5 cm and a diameter in the range of from about 0.3 to about 0.8 cm has been tested in several applications with good results. For the mitigation of wind erosion it is expected that aggregates having a high surface area/volume ratio will provide the most desirable results.

For agricultural applications the aggregates will generally be applied in an amount of between about 1000 kg/ha to about 28,000 kg/ha, although where simple disposal of waste

paper is the objective, the amounts could be on either side of this range. Usually, the aggregates are applied in an amount of between about 1000 kg/ha to about 20,000 kg/ha. For annual use, it is expected that the aggregates will be applied in an amount of between about 3,000 kg/ha to about 8,000 kg/ha although greater amounts than this such as in the range of from about 6,000 kg/ha to 20,000 kg/ha, are expected to be beneficial when the objective is the mitigation of wind erosion. For wind erosion control, ground cover of between about 20% and about 40% should provide good results. Smaller aggregates are more economical for this application than larger ones since they have a high surface area/volume ratio, but the aggregates should have sufficient mass to avoid wind displacement. For weed control, smaller amounts of aggregate can be used, such as in the range of from about 1,000 kg/ha to 6,000 kg/ha, by applying the aggregate along the base of the growing plants, optionally in a shallow trench to aid in placement.

The aggregates can be applied to the soil in any desired manner. Generally, the aggregates will be broadcast on the soil surface, and this is the preferred technique where the objective is control of weeds and wind erosion. Generally speaking, for quickest assimilation, it is desirable to mix the aggregates with the soil. This can be accomplished by conventional tilling after the aggregates have been broadcast on the soil surface. Where it is desired to reduce soil density, the aggregates can be worked deeply into the soil, but will generally be tilled into the soil to a depth of no greater than 61 cm. Beneficial results can also be obtained by burying a mixture of aggregates and soil in a trench and where soil compaction severely limits plant root depth, this technique provides good results. Usually, however, the aggregates will be tilled into the soil to a depth of no greater than about 15 cm because this can be accomplished using standard farm implements.

As mentioned, one of the effects of tilling the aggregates into the soil is a reduction in soil density. The aggregates generally have an apparent bulk density in the range of from about 100 kg/m^3 to about 830 kg/m^3 at a moisture level of about 16% by weight. Usually, the aggregates have an apparent bulk density in the range of from about 180 kg/m^3 to about 550 kg/m^3 at a moisture level of about 16% by weight. Larger aggregates have bulk densities

in the higher end of the ranges given. Smaller aggregates have bulk densities in the lower end of the ranges given.

The aggregates apparently compete with growing plants for nitrogen. This prevents the pellets from being beneficial to the plants for an incubation period of several weeks. This problem can be overcome by applying the pellets several weeks before planting season, such as in the fall, or by applying a growth promoter such as a nitrogen source to the soil, either directly or by incorporation into the pellets. Commercial fertilizers can be used. When commercial fertilizers are used, they are generally selected from ammonium nitrate, ammonium sulfate and urea. Application is in an amount sufficient to provide a C:N atomic ratio between nitrogen from the nitrogen source and carbon from the ground paper of between about 10:1 to about 60:1. Animal wastes are the preferred source of nitrogen, because they seem to be more rapidly assimilated. In order of decreasing preference, poultry litter, cattle manure, swine manure, horse manure and sheep manure may be used. A sufficient amount is applied to provide a C:N atomic ratio between nitrogen from the nitrogen source and carbon from the ground paper of between about 20:1 to about 60:1, most preferably about 30:1. Other growth promoters such as micronutrient combinations can be incorporated into the aggregates as well, and are preferably present where the aggregates are to be used as a soil replacement or soil amendment.

In the most preferred embodiment of the invention, the nitrogen source is incorporated into the pellets. The same nitrogen sources can be used as mentioned above. The nitrogen source is generally incorporated into the aggregates during the manufacturing operation to provide a C:N atomic ratio between nitrogen from the nitrogen source and carbon from the ground paper of between about 20:1 to about 60:1. In this embodiment of the invention, the aggregates will generally comprise from about 1% to about 3% of nitrogen, on an elemental basis. However, the aggregates can be used with a prime function of acting as a carrier for the nitrogen source. When this is the case, a nitrogen source such as commercial fertilizer is present in the aggregate in the same amounts contemplated for the non-paper waste material. Generally speaking, however, in such case the nitrogen source will be present in the amount of 0.1 to 10% by weight, usually from about 0.5 to 5.0% by weight. Where animal waste is

used as the nitrogen source, the processing temperatures should be kept low in order to preserve sufficient microorganisms to speed assimilation into the soil.

In another embodiment of the invention, there is provided aggregates which comprise non-paper waste material, optionally in aggregation with paper. Preferably, the aggregates are in the form of pellets or crumbled pellets. The non-paper waste material can be selected from organic and inorganic sources. Organic sources include wastes from the timber and wood products industry, such as wood, wood chips, lumber, and sawdust, wastes from landscaping work such as brush, branches, grass clippings, leaves, and other yard wastes, wastes from agricultural operations such as straw, stalks and leaves; wastes from the processing of agricultural products, such as gin trash, bagasse, grain hulls, peels, sorghum, sugar cane, animal byproducts, food industry sludges, paper industry sludges, clothing industry wastes or consumer wastes such as discarded clothing and furniture. Examples of inorganic wastes include wastes from the building industry such as sheetrock, gypsum, roofing materials, insulating materials such as fiberglass and foam board, and lumber; consumer wastes such as plastics, polystyrene, and rubber goods, and industrial sludges such as API separator bottoms and gas scrubber residues, for example. Generally speaking, it is not preferred to incorporate high levels of inorganic wastes into the pellet product except where the pellet is to be used for the prevention of soil erosion. It is generally preferred that the non-paper waste materials originate from organic sources. To form the pellets, the non-paper waste material is first ground to a particle size suitable for pellet or briquette formation. Generally, the material is ground to a screen size of 10 cm or less, usually, to a screen size of 3 cm or less, and preferably to a screen size of between about 0.2 and about 2 cm. Hammer mills can be used. The aggregates thus contains discrete particles of non-paper waste material in comminuted form. The material is then pelletized or briquetted. If necessary, moisture is added in an amount sufficient to facilitate the completion of pellet or briquette formation. Small sized aggregates can be formed, if desired, by crumbling the pellets or briquettes. The aqueous medium may contain a binding agent to facilitate pelletizing. Binding agents include paper products, clay, or starch based adhesives, for example. Preferably, the binding agent comprises paper prepared as hereinabove described.

The aqueous medium can be selected from a wide range of sources. Water is suitable. Other aqueous mediums containing organic matter are also suitable. Sewer sludges, paper pulp sludges, sludges containing animal wastes such as chicken litter and/or cattle manure, and slaughterhouse wastes are all suitable. Where the pellet product is to be used for purposes other than the prevention of wind erosion, the aggregate preferably contains a growth promoter. This can be incorporated into the product during the pelletizing process. The aqueous medium can contain a source of assimilable nitrogen, for example, which is sufficient to provide the pellet product with a ratio of nitrogen to biodegradable carbon in the range of from about 1:20 to about 1:60, on an atomic basis. Fertilizers and other plant growth promoters can be used for this purpose. For potting plants and nurseries, fertilizers and other plant growth promoters are extremely desirable.

When paper is present as the binding agent, it can be present over a wide range in the pellet product. For example, the paper can be present in an amount to provide the pellet product with a paper content in the range of from about 1% to about 99% by weight. For the reduction of wind erosion, the pellet product may contain a high amount of inorganic material, for example, in the range of from about 75 to 100% of inorganic material. Where the pellet is to be used as a soil replacement or for soil enhancement, it is preferred that the pellet contain a high content of organic matter, such as in the range of from about 50% to 99% of organic matter. Growth promoters such as fertilizers and other plant nutrients are also preferably present, especially when the pellet is to be used for purposes other than the prevention of wind erosion, or simply as a means to facilitate disposal of the non-paper product. The resulting pellets can be used in the same manner as described elsewhere herein. The pellets may be crumbled before use if desired, and it is preferred that the pellets be crumbled where use as a growth medium is desired.

Paper products may inhibit plant growth due to aluminum toxicity. Where good plant growth is desired, it is preferred to treat the aggregates with an agent which will counteract the effects of the aluminum. Poultry waste has been used with good results.